

Special topics graduate course
Inverse modeling and data assimilation for Earth System Sciences

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ATOC 7500-001 (call #85299)
Fall 2006
Mondays and Wednesdays from 10:00-11:15am in STAD 136C

SYLLABUS

Goals

- Understanding of purpose of the inverse modeling and data assimilation in the Earth System sciences
- Understanding of mathematical and statistical theoretical basis of inverse modeling and data assimilation methods
- Detail derivation of major classes of numerical techniques from the theory to aid the student in selection and further development in applications
- Understanding of characteristics of modeling and measurements in the Earth System science's inverse problem solving
- Understanding of applicability of techniques in the physical analysis
- Tutorial numerical exercises in Matlab with selection of prototype modeling problems

Schedule of sessions

Week 1 (Aug 28 and 30)

1. Why inverse modeling and data assimilation?

- 1.1. Purpose and nature of modeling in the Earth System sciences
- 1.2. Relevance of inverse modeling and data assimilation in the Earth System research and applications

2. Observations of the Earth system: Direct and indirect measurements

Weeks 2-4 (Sept 6, 11, 13, 18 and 20)

3. Basics of inverse problem solving and data assimilation

- 3.1. Model and parameter space
 - 3.2. Measurement space
 - 3.3. Probabilistic nature of information
 - 3.4. General inverse problem and solution
 - 3.5. Discrete probability density (exercises)
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Weeks 5-10 (Sept 25 and 27, Oct 2, 4, 9, 11, 16, 18, 23, 25 and 30, Nov 1)

4. Inverse modeling and data assimilation techniques (derivation and exercises)

- 4.1. Monte Carlo
 - 4.2. Kalman Filter
 - 4.3. Variational least squares
 - 4.4. Ensembles
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Week 11 (Nov 6 and 8)

5. Consideration of modeling errors

Week 12 (Nov 13, 15)

6. Parameter estimation: data assimilation for hypothesis testing and improving models

Week 13 is Fall Break (Nov 20-24)

Week 14 (Nov 27 and 29)

7. Observability and Predictability

Week 15 (Dec 4 and 6)

8. Dynamic system sensitivity analysis

Week 16 (Dec 11 and 13)

9. Review and student presentations (class projects)